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Chinese Cabbage Varieties, Their Classification, Description, and Culture in the Central Great Plains

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INTRODUCTION

The production of Chinese cabbage in the United States is confined chiefly to localities near the large cities. New Jersey, New York, Ohio, Michigan, Illinois, Indiana, and California produce considerable quantities for nearby markets, and marketing is usually done by truck. The exact acreage produced is not known, because Chinese cabbage is not regularly included in crop reports or other agricultural statistics. However, it is estimated that Florida grows approximately 500 acres annually, most of the crop being shipped to distant markets.¹

Few figures are available on the marketing of this crop, because it is usually listed under the term "greens" and shipped in mixed carloads. Only in the cities of New York, Boston, Chicago, and Philadelphia was Chinese cabbage listed separately in the unload reports of fruits and vegetables for 1938.² Nevertheless, this vegetable may be found during some seasons of the year in most vegetable markets in

¹ Personal correspondence from Paul Work, New York State Agricultural Experiment Station; Joseph H. Boyd, Ohio Agricultural Experiment Station; J. B. Corns, Illinois Agricultural Experiment Station; E. C. Stair, Indiana Agricultural Experiment Station; John H. MacGillivray, California Agricultural Experiment Station; and F. S. Jamison, Florida Agricultural Experiment Station.

² Personal correspondence from B. C. Boree, Market News Service, Bureau of Agricultural Economics, Washington, D. C., and the Annual Reports of Unloads of Fruits and Vegetables at Boston, New York City, Chicago, and Philadelphia for 1938.

the United States, which indicates that there is a rather widespread demand for it. In favorable localities it should prove to be a desirable and profitable vegetable crop.

In the central Great Plains and the adjacent Rocky Mountain area, home and market gardeners have generally not recognized the possibilities for growing Chinese cabbage. However, in these relatively high altitudes the warm days and cool nights of autumn are especially conducive to best head formation. Probably the chief reason why it is not grown more in this area is that many varieties will not form desirable heads unless planted at the proper time and given rather careful culture. Another limiting factor in growing Chinese cabbage, not only in this area but generally throughout the country, is the confusion of nomenclature. This confusion exists to such an extent that what is listed as a variety by one seedsman may be used by another as a generic name for Chinese cabbage. Thus when a grower is buying seed he has no assurance that he is obtaining the variety he desires.

As a part of the varietal test work with vegetables conducted at the Cheyenne Horticultural Field Station, Cheyenne, Wyo., approximately 30 varieties or strains of this vegetable have been grown and observed. They have been classified and described primarily from the standpoint of head type and adaptability. Their classification and description together with the general cultural requirements for the central Great Plains and uses of the crop are reported in this circular.

HISTORY AND NOMENCLATURE

Chinese cabbage is thought to be a native of China, but as is true of many present-day plants it is difficult to determine exactly what plant was referred to in the ancient writings. According to Bretschneider (4),³ the plant now known as *Brassica chinensis* was mentioned in the first Chinese treatise dealing with plants, which was written by Ki Han, of the Chin Dynasty, A. D. 290-307. It was listed again as a vegetable whose leaves were used for food, in a treatise on plants "fit for supporting life in time of scarcity" by an Imperial Prince, the fifth son of the first Ming Emperor, Hung Wu, who reigned A. D. 1368-1398. Bretschneider (4) has identified this plant as *B. chinensis* var. *oleifera*.

Burr (5) in 1865 described both Pak-Choi and Pe-Tsai cabbages. Both are listed as Chinese cabbage, but he refers to Pak-Choi as *Brassica species*, and to Pe-Tsai as *B. chinensis*. From the descriptions, however, it is readily apparent that his Pe-Tsai was the plant that is now designated as *B. pekinensis*.

Bailey (2) has done an immense amount of work on the identification and classification of the cultivated Brassicas. He shows that the description of *Sinapis pekinensis* by Loureiro, a Portuguese missionary to China in 1790, corresponds to that of the present day *Brassica pekinensis* Rupr. This is the same plant sometimes referred

³ Italic numbers in parentheses refer to Literature Cited, p. 19.

to in horticultural writings as *B. pe-tsai*. *B. chinensis* L. is described by Bailey as Pak-Choi cabbage or Chinese mustard. The main difference as given by Bailey between these two species is the character of the petioles. The petioles of the radical and lower stem leaves of *B. pekinensis* are very broad, flat, and tooth-winged. Those of *B. chinensis* are not so broad, are thicker, and are not prominently winged. Bailey states, however, that the latter species is not very distinct, that it and Pe-Tsai are uniformly associated with each other in horticultural writings, and that their individual histories cannot be separated.

In the United States, *Brassica chinensis* seems to be of little value as a garden vegetable, a fact which is aptly summed up by Bailey (1) as follows: "I cannot see that it is destined to become even an important secondary vegetable in America."

Seed of *Brassica chinensis* has been obtained in the United States, and it is frequently listed as Chinese cabbage. In some cases, however, it is listed under the name Chinese mustard.

The nomenclature of horticultural varieties of Chinese cabbage offered in the seed trade is often very confusing. The term Pe-Tsai is used in some foreign and in some American seed catalogs to denote a distinct variety of Chinese cabbage. One catalog from the Orient⁴ states that in Japan there are more than 50 varieties in use, most of which have been developed from 4 original strains, namely, Wong Bok, Chee-Hoo, Pe-Tsai, and Chihli. Other seed companies of the Orient and some in the United States list all varieties under the term Pe-Tsai, the latter referring to the vegetable, Chinese cabbage. In nearly all American catalogs that list the vegetable the term Pe-Tsai refers to a distinct variety, but when grown it is often difficult to distinguish it from Wong Bok. The latter variety is commonly listed in the American seed trade.

These few examples serve to show the confusion existing in nomenclature, and indicate the value of the classification and description of Chinese cabbage varieties.

METHODS

Plants of each variety were grown each of the 4 years of the present study in plots of suitable size to obtain a fair indication of its type. During the first 3 years duplicate plots were grown, but for the last year's descriptions only a single plot was used. Seeding was done in the field about June 5 of each year, and the plants were grown as for commercial production.

All varieties were described in the field by direct comparison with each other in regard to the characters studied. The classification of the varieties described in this circular is based primarily on horticultural characters of commercial importance. The botanical terminology used in the classification and descriptions is that recommended in the Glossary of Botanical Terms Commonly Used in Range Research

⁴ Takii & Co., Ltd., Kyoto, Japan. 1933 catalog.

(7). The characters of most consequence to the gardener are (1) whether or not a variety will head, and (2) the type of head it produces. The first of these characters is dependent to a large extent upon the environmental conditions, as will be shown later (p. 16). In these tests it has been difficult to obtain a large number of heads of some of the varieties. For most of the varieties, however, sufficient samples of the head type have been observed during at least one of the years in which the tests were conducted. A few of the varieties grown are of distinctly nonheading type. They appear to be similar to leaf lettuce in growth habit, and are sometimes referred to as Chinese lettuce.

Other characters observed in the descriptions are growth habit of the plant, size of the plant, presence and distribution of setae on leaf surfaces, leaf color, leaf shape, degree of savoying, and number and arrangement of secondary veins. Growth habit refers to the relative degree of erectness as judged by the general appearance of the plant. Size of the plant varies with environmental conditions; the sizes given in the descriptions represent measurements of typical plants as grown at Cheyenne, Wyo. Most varieties that belong to the true heading group have setae present on both surfaces of the leaves and petioles, whereas the nonheading varieties, with the exception of Hagaromo, have no setae on either surface. The variety Chihli was taken as the standard for comparison. It has the highest number of setae, and other varieties are rated by actual comparison of the number of setae on the leaves to the leaf of Chihli. Leaf color varies from light yellowish green to dark green, and it is distinct for each variety. In determining the leaf color of any variety, direct comparisons were made in the field, and a numerical rating was given for each. Degree of savoying of the leaf refers to its depth. Some varieties appear finely savoyed, whereas others are coarsely savoyed and appear somewhat similar to savoy cabbage. The difference between these two types is actually due to the depth of puckering between the small veins. Arrangement of secondary veins is very distinct for the varieties. The variety Chihli is characterized by veins that are comparatively small, numerous, and arranged in such a way that they appear parallel to each other. The variety Wong Bok is characterized by veins that are larger than those of Chihli and that appear to diverge rather than to parallel each other. All of the varieties can be rather definitely classified into one or the other of these two groups.

The varieties grown in these trials under the names Nagasaki and Goldinheart have not been included in any of the groups. Goldinheart was offered by a Japanese seed company in 1933 as a novelty and was reported as a hybrid between Chinese cabbage and some broadleaved mustard. Nagasaki is described in Japan as a heading type of Chinese cabbage, but it has never formed heads in the variety trials at Cheyenne. Although it probably should be placed in a subclass under the Chihli group, its classification according to head type is doubtful.

Although definite classification of these two varieties has not been made, they are, nevertheless, described and illustrated for general information.

KEY TO VARIETIES OF CHINESE CABBAGE

I. Leaves obovate. Petioles short, broad, prominently winged, flattened or only slightly concave on adaxial surface.

A. Plants forming true heads. Leaves setose.

B. Heads long and narrow with leaf tips overlapping to form pointed apex. Plants erect. Leaves dark green, finely savoyed. Secondary veins many, appearing parallel.

GROUP 1. TYPE VARIETY—CHIH LI

BB. Heads medium to long with leaves curving outward at tips. Plants semierect. Leaves intermediately green, coarsely but heavily savoyed. Secondary veins medium in number, palmate.

GROUP 2. TYPE VARIETY—PE-TSAI

BBB. Heads round or only slightly oblong with leaf tips overlapping. Plants spreading. Leaves intermediately green, moderately savoyed. Secondary veins medium to few in number, palmate.

GROUP 3. TYPE VARIETY—WONG BOK

AA. Plants not forming true heads.

B. Leaves setose.

C. Leaf margins incised, very wavy. Leaves intermediately green, moderately savoyed.

GROUP 4. TYPE VARIETY—HAGAROMO

BB. Leaves glabrous.

C. Leaf margins incised, very wavy. Leaves light yellowish green, coarsely but lightly savoyed.

GROUP 5. TYPE VARIETY—GIANT SHUNTANG

CC. Leaf margins entire to slightly undulate. Leaves light yellowish green, surfaces generally smooth, but occasionally very slightly savoyed.

GROUP 6. TYPE VARIETY—SANTO-SAI

II. Leaves orbicular. Petioles as long as leaf blade, not prominently winged, deeply and narrowly concave on adaxial surface.

A. Plants not forming true heads, erect. Leaves not overlapping, dark green, glabrous, thickly covered with bloom, not savoyed. Leaf margins entire, very slightly waved.

GROUP 7. TYPE VARIETY—NEW JOY

DESCRIPTION OF VARIETIES

GROUP 1

Type variety: Chihli (fig. 1).



FIGURE 1.—Single leaf and plant of the variety Chihli.

Synonyms: Improved Pekin, Improved Peking, Peking Chihli.

Season: Early.

Plant: Vigorous, medium to large, usually 15 to 20 inches in height and 15 to 18 inches in breadth. Growth habit erect. Leaves intermediate in size, obovate, dark green, moderately glossy, without bloom, margins crenate, basal portion incised, wavy and winged. Upper and lower leaf surfaces slightly savoyed, thickly covered with setae evenly distributed on veins. Secondary veins many, nearly parallel. Petiole and midrib $1\frac{1}{2}$ to 2 inches wide at base, greenish white, slightly concave, thickly covered with bloom.

Head: Long and slender, 15 to 18 inches long and 4 to 6 inches in diameter. Leaves clasping to form a compact, pointed head; inner leaves bleached to creamy white at maturity. One of the most reliable heading varieties under the climatic conditions in which it was tested.

Similar varieties or strains: Special Narrowhead.—As grown in the trials at this station, this variety is practically identical to Chihli.

Korean Specy No. 239.—This lot consists of mixed types. The majority of the plants are identical to those of Chihli but there are some plants similar to Wong Bok.

GROUP 2

Type variety: Pe-Tsai (fig. 2).



FIGURE 2.—Single leaf and plant of the variety Pe-Tsai.

Synonyms: The true type of this variety appears to be distinct from all other varieties, but many seedsmen use this name interchangeably with all the other varieties of Chinese cabbage and, as mentioned before (p. 3), the term is often used for the crop in general.

Season: Midseason to late.

Plant: Vigorous, large, 10 to 15 inches in height, and approximately 30 inches broad. Growth habit semierect. Leaves large, obovate, intermediately green, moderately glossy; margins slightly reflexed, somewhat waved, upper portion undulate, lower portion incised and winged. Leaf surfaces moderately coarsely savoyed, both upper and lower thickly covered with setae, evenly distributed. Secondary veins medium in number and diverging from each other. Petiole and midrib 2 inches broad at the base, white, slightly concave on upper surface, with small amount of bloom.

Head: Medium to large, 10 to 12 inches long and 4 to 6 inches in diameter. The head approaches that of Chihli in shape but is typically shorter than the latter variety. Heads of the group characterized by this variety are usually open at the apex instead of having the leaves folded over each other to make a pointed head as in group 1.

Similar varieties or strains: Chinese White and White Mammoth.—These are strains of Wong Bok in which the greenish cast of the leaf petioles is practically absent, making them appear more nearly pure white than is characteristic for the true Wong Bok.

Chokurei.—As grown in these trials, this variety was identical with Pe-Tsai.

Seoul Market.—It is very similar to Pe-Tsai except that it produces a slightly longer head.

Hakusai No. 1 and Japanese Aichi.—These two varieties are so similar they could probably be listed as identical. They have the general plant and leaf characters of Pe-Tsai, but they produce smaller plants and shorter heads than the latter variety.

Sakigake and Spring Giant.—Like Hakusai No. 1 and Japanese Aichi, these varieties have the same characteristics of Pe-Tsai, and produce shorter heads, but they differ from them in the fact that they are considerably earlier maturing. Sakigake was the earliest heading variety of those tested.

Market Pride.—This variety has the general characteristics of Pe-Tsai, but like several of the other varieties in this group, it produces a head that is considerably shorter. It more nearly resembles Japanese Aichi or Hakusai No. 1 in head shape, but the head is typically shorter and more compact than those of the latter varieties.

GROUP 3

Type variety: Wong Bok (fig. 3).

Synonym: Paoting.

Season: Late.

Plant: Vigorous, large, 12 to 15 inches in height and approximately 30 inches in breadth. Growth habit spreading. Leaves very large, obovate, intermediately green, moderately glossy, without bloom; margins, upper portion undulate, lower portion incised, reflexed, slightly waved and winged. Leaf surface moderately savoyed, both upper and lower surfaces thickly covered with setae, evenly distributed. Secondary veins medium to few in number, diverging from each other rather than parallel in appearance. Petiole approximately 2 inches broad at base, slightly concave, greenish white, heavily covered with bloom.

Heads: Short and broad, usually 8 to 10 inches long and 6 to 8 inches in diameter. Leaves clasping to form a compact rounded head; inner leaves bleached to creamy white at maturity. Many strains of this variety are not uniform in plant type or head shape. It is often difficult to obtain heads of this variety under the climatic conditions in which it was tested because the seedstalks form when the plants are very small.

Similar varieties or strains: Tsujita and Unzen.—In all important characters both of these varieties are similar to Wong Bok. Under the climatic conditions in which they were tested both formed seedstalks when the plants were comparatively small.

Chugaiyens Mammoth.—This variety is of the same general type as Wong Bok, but the heads attain larger size.



FIGURE 3.—Single leaf and plant of the variety Wong Bok.

Cheefoo or Chee-Hoo, Market Pioneer, Hakusai No. 2, Hotoren.—These four varieties are very similar to Wong Bok in general plant characteristics, except that they are darker green and the leaves are more heavily savoyed. Cheefoo and Hakusai No. 2 are exceptionally uniform strains, and they do not form seedstalks as quickly as does Wong Bok and many other varieties in the group. A large percentage of plants form excellent heads, even in seasons when adverse climatic conditions prevail. The heads are of approximately the same length as those of Wong Bok, but they are somewhat smaller in diameter. All four varieties are somewhat earlier maturing than Wong Bok, and because of their long-standing ability they should be given further trial in those locations where seedstalk formation takes place early in the season.

Conical Giant.—In plant characteristics this variety is similar to other varieties in the Wong Bok group, but it forms a more conical-shaped head.

GROUP 4

Type variety: Hagaromo (fig. 4).



FIGURE 4.—Single leaf and plant of the variety Hagaromo.

Synonyms: None.

Season: Midseason to late.

Plant: Vigorous, large, 10 to 15 inches in height and approximately 30 inches in breadth. Growth habit semierect. Leaves large, obovate, intermediately green, slightly glossy, without bloom; margins, both upper and lower portions incised and very wavy; leaf surface coarsely savoyed; upper surface with only a few scattered setae, lower surface thickly covered with setae, evenly distributed. Secondary veins diverge from each other. Petiole approximately 2 inches broad at the base, very slightly concave, white, heavily covered with bloom.

Head: This variety does not form compact heads. It is a loose-leaf type, similar to leaf lettuce in appearance. The inner leaves become yellowish white at maturity.

Similar varieties or strains: None.

GROUP 5

Type variety: Giant Shuntang (fig. 5).



FIGURE 5.—Single leaf and plant of the variety Giant Shuntang.

Synonyms: None.

Season: Late.

Plant: Vigorous, medium to large, 12 to 15 inches in height and approximately 30 inches in breadth. Growth habit, semierect. Leaves large, obovate, light yellowish green, only slightly glossy, moderately covered with bloom, glabrous, slightly and coarsely savoyed; margins both upper and lower portions deeply incised and very wavy. Secondary veins diverging from each other rather than parallel. Petiole large, 2 inches wide at the base, white, very slightly concave with only a slight amount of bloom.

Head: Loose-leaf type similar to Hagaromo.

Similar varieties or strains: Yellow Shuntang.—This variety differs from Giant Shuntang in that it is earlier maturing, is somewhat smaller, and the leaf margins are less wavy and less deeply incised.

GROUP 6

Type variety: Santo-Sai (fig. 6).



FIGURE 6.—Single leaf and plant of the variety Santo-Sai.

Synonyms: None.

Season: Midseason to late.

Plant: Vigorous, medium in size, 10 to 12 inches in height, and 20 to 24 inches in breadth. Growth habit semierect to spreading. Leaves large, obovate, light yellowish green, moderately glossy with medium bloom; leaf margins, upper portion undulate and slightly reflexed, lower portion crenate, very slightly waved. Leaf surface smooth, rarely with very slight savoying, glabrous; secondary veins medium in number, diverging from each other. Petiole white, broad, winged, very slightly concave, heavily covered with bloom.

Head: Does not form heads, but rather a loose bunch of leaves similar to Hagai-romo and Giant Shuntang. This variety is sometimes referred to as Chinese lettuce. Bailey (1) reports that he grew a variety in 1894 under the name "Santo Tsai" which was of the heading type, and in a later paper (2) he states that he grew a variety under the name "Santo-sai" which was similar to Pe-Tsai. The variety grown in the present trials under this name, however, is of the nonheading type and is distinct from the true Pe-Tsai variety.

Similar varieties or strains: None.

GROUP 7

Type variety: New Joy (fig. 7).



FIGURE 7.—Single leaf and plant of the variety New Joy.

Synonym: Sometimes referred to as Chinese mustard.

Season: Late.

Plant: Often weak growing, medium to small, approximately 15 inches in height and 18 inches in breadth. Growth habit erect. Leaves small, orbicular, dark green, moderately glossy, heavily covered with bloom. Margins entire, upper portion sometimes very slightly undulate, not waved. Leaf surface without savoying, glabrous. Petiole as long as leaf blade, not winged, white, deeply concave on adaxial surface, narrow, heavily covered with bloom.

Head: Not a heading type. This variety represents the type described by Bailey (2) as Pak-Choi cabbage or *Brassica chinensis*. The petioles of the leaves are the edible portions. It is entirely distinct from all other varieties described. In general plant characteristics the plants are similar to those of true cabbage (*B. oleracea* L.). It is of very little value and does not appear to possess any desirable characters that are not present in the heading types of Chinese cabbage.

Similar varieties or strains: None.

NAGASAKI⁵

Synonyms: None.

Season: Midseason to late.

Plant: Medium to weak in growth, small, approximately 10 inches in height and 15 inches in breadth. Growth habit semierect to erect. Leaves intermediate to small, obovate, light to very light yellowish green, slightly glossy, with medium



FIGURE 8.—Single leaf and plant of the variety Nagasaki.

to heavy bloom. Margins undulate, very strongly reflexed, not wavy, surfaces of leaves very heavily and coarsely savoyed similar to savoy cabbage, glabrous. Petiole white, flat, 1 to 1½ inches in diameter at base, heavily covered with bloom (fig. 8).

Head: This variety has never formed solid compact heads in these trials, but has shown a tendency to form heads similar to those of Chihli. It is described in Japan as forming a head similar to the latter variety.

⁵ The exact position that should be given to this variety in the classification is in doubt, but it probably should be placed in the Chihli group.

GOLDINHEART

Synonyms: None.

Season: Midseason to late.

Plant: Weak growing, small, approximately 8 inches in height by 15 inches in breadth. Growth habit semierect. Leaves medium in size, obovate, intermediate green, slightly glossy with slight amount of bloom on upper surface, but heavily covered with bloom on lower surface. Margins undulate, slightly reflexed and



FIGURE 9.—Single leaf and plant of the variety Goldinheart.

not waved, leaf surfaces heavily savoyed, glabrous. Secondary veins of diverging type, medium in number. Petiole white, flat, 1 to 1½ inches in diameter, heavily covered with bloom (fig. 9).

Head: This variety has never formed heads in the trials at Cheyenne, Wyo. According to the seedsmen (Takii & Co., Kyoto, Japan) offering this variety it is a cross between Chinese cabbage and some broad-leaved mustard. It has not shown much promise and it is doubtful if it warrants further trial.

Similar varieties or strains: In general, the plant and leaf characters of this variety are similar to those of Nagasaki, but it is darker green, not as heavily savoyed, and the leaves are covered with a much heavier bloom.

Figure 10 shows the principal head types of Chinese cabbage. The head of Chihli on the left is typical of group 1. The two center heads represent the longer and shorter heads of group 2, and the head on the right is typical of group 3.



FIGURE 10.—Principal head types of Chinese cabbage. From left to right: Chihli, Seoul Market, Japanese Aichi, and Cheefoo.

CULTURE OF CHINESE CABBAGE

Nissley (9) has given general directions for the culture of Chinese cabbage in New Jersey. The additional information given herein is primarily for its culture in the Great Plains, but in general it will apply to any section with climatic conditions similar to those of Cheyenne, Wyo.

Chinese cabbage may be grown either by seeding in the field where it is to mature, or by seeding in the greenhouse or hotbed and transplanting the plants into the field when they have reached 3 to 4 inches in height. The transplanting method may be used where an early spring crop is desired in order to get the plants into the field and enable them to start heading before the longer hotter days of the summer months. However, for a spring crop as well as for a fall crop it is usually better to seed in the field rather than to attempt transplanting the seedlings, because best development is obtained if the growth of the plants is not checked. If the spring crop is seeded in the field, one of the longer-standing varieties, such as Cheefoo or Hakusai No. 2, should be used.

According to Bremer (3) Chinese cabbage is a long-day plant, and varieties differ in their response to photoperiod. His data indicate that Wong Bok is the longest-standing variety, but that there is very little difference between it and Chihli, whereas Pe-Tsai forms seedstalks early in the season, even under a rather short day.

Varieties grown in the trials at Cheyenne show very distinct differences in their long-standing ability. As pointed out in the descriptions of the several varieties, Cheefoo and Hakusai No. 2 appear to be exceptionally long-standing; they have always formed

at least a considerable number of heads regardless of the time of planting, although it is difficult to obtain any heads of Wong Bok when it is planted as a spring or summer crop. Even when planted as a fall crop, the latter variety forms seedstalks quickly and produces only a small percentage of heads at Cheyenne. This fails to support the work of Bremer (3), and indicates that factors other than day length may cause premature seedstalk formation. Temperature and soil moisture supply are probably important factors.

An experiment was conducted in 1938 to obtain data on the relation of time of seeding in the field to number of heads produced, and to determine the most suitable time of planting for locations similar to that of Cheyenne. Table 1 shows the results obtained in percentage of plants producing marketable heads. The varieties Chihli and Wong Bok were used for this study, because they represent early and late-maturing varieties, respectively.

TABLE 1.—*Mean percentages of plants forming heads of varieties Chihli and Wong Bok planted at different dates*

[Amount required for significance between any 2 means in the table is 12.07 percent, if odds of 19 to 1 are accepted as a criterion.]

Date of planting	Plants forming heads		Date of planting	Plants forming heads	
	Wong Bok	Chihli		Wong Bok	Chihli
	Percent	Percent		Percent	Percent
May 1.....	0.00	8.54	June 15.....	34.32	92.28
May 15.....	15.98	19.35	July 1.....	27.18	86.59
June 1.....	22.80	91.84	August 1 ¹00	.00

¹ No heads were formed by the August 1 planting, because the plants were killed by frost before sufficient time had elapsed for head formation.

Four replications of each variety were used for each date of planting and they were randomized in order that the analysis of variance (12) could be used on the data. The results indicate that there is little use of planting either variety in the field before June 1 if heading is desired. If the variety Chihli is planted after June 1, there is no difference in the percentage of heads formed except when planted so late that it will not mature before killing frost. However, the data obtained indicate that Wong Bok should not be planted in the field before June 15 in locations with climatic conditions similar to those of Cheyenne. One other significant fact shown by the data is that when planted in June or July the variety Chihli forms a much larger percentage of heads than does Wong Bok.

When the crop is seeded in the field and the plants reach a height of 3 to 4 inches, they should be thinned to approximately 2 feet in the row. The larger spreading varieties, such as Wong Bok and Cheefoo, may require a 30- to 36-inch spacing when grown under conditions of ample moisture. The rows should be 3 to 3½ feet apart. Approximately the same cultural practices are necessary for this crop as are used for other cole crops. It requires a considerable amount of moisture for proper development, and this is often the limiting factor in its production.

HARVESTING AND STORING

When heading varieties are grown, the plants are harvested in the same manner as cabbage or cauliflower. If nonheading types are grown they may be harvested at any time after the leaves have reached edible size. According to Thompson (14) no uniform type of package is used for commercial shipment of Chinese cabbage because the crop has not reached sufficient importance to demand a special package. He reports, however, that it is shipped to some extent in lettuce and celery crates.

In China (16) the plants are stored in the following manner: After the first frost the plants are pulled and left drying in the field for a day or two. The outer leaves are removed and the heads piled on each other in outside cellars or trenches. They are then covered with dry straw and a layer of soil. In this manner they may be kept well into the winter without appreciable loss.

In the United States, Thompson (14) reports that the heads have been kept successfully in cold storage for a period of 2 months.

USES

The flavor of Chinese cabbage is distinct, sweet, and mild. It is often eaten uncooked in the same manner as celery, and it is frequently referred to as celery cabbage. The young plants, especially those of the nonheading types, are sometimes boiled and eaten like spinach. Stout (13) gives the following uses for the vegetable: "As a salad, the only plant that rivals it is witloof chicory. It may be used as a salad, as a cole-slaw, as asparagus, or as spinach." Fairchild (8) states that Pe-Tsai is one of the staple vegetables of chop suey sold in American Chinese restaurants. In the description of a Chinese winter cabbage, referred to as *Brassica pekinensis*, introduced by the Division of Foreign Plant Exploration and Introduction (16) it is reported "to be much more easily digested than ordinary cabbage and to emit no offensive odors when being boiled."

INSECTS AND DISEASES

There are several species of flea beetles which may attack Chinese cabbage, but the one most commonly found in the Mountain and Central Plains States is the western cabbage flea beetle (*Phyllotreta pusilla* Horn) (10). If it is not controlled, this insect will destroy the small plants by chewing many small holes in the leaves. It is practically a hopeless task to attempt to completely control these insects by spraying with stomach poisons, but the use of sprays or dusts in conjunction with materials that act as repellents will usually control them until the plants are well established and less likely to be severely injured. Crosby, Chupp, and Leiby (6) give recommendations for control of the striped flea beetle (*Phyllotreta vittata* Fabricius), and these are probably equally applicable for the control of the western cabbage flea beetle. They state that small seedlings will usually be protected from injury by making heavy applications of fine tobacco dust containing at least 1 percent of nicotine. A good rate of application is 1 pound of dust to 150 to 200 feet of row. These writers also

state that the flea beetles may be controlled effectively by the use of 1 percent rotenone dust if the applications are made frequently and thoroughly.

Occasionally, cabbage aphids and cabbageworms become serious insect pests. Shropshire and Kadow (11) state that a 2.4-percent nicotine dust applied to both upper and lower surfaces of the leaves will control the cabbage aphids if applied when the temperature is above 70° F. and the atmosphere is fairly quiet. This dust is not effective when applied to wet surfaces on plants. The imported cabbageworm (*Ascia rapae* L.) is the most serious of the worms which attack Chinese cabbage in the Great Plains area. Shropshire and Kadow (11) state that this insect can be controlled by the use of rotenone dusts containing at least 0.5 percent of rotenone. This is applied at the rate of 20 to 30 pounds per acre. Occasionally, the cabbage looper (*Autographa brassicae*) attacks Chinese cabbage plants. According to Thompson (14) pyrethrum dusts are more effective for its control than rotenone dust. If pyrethrum extract is used for the dust it should contain at least 0.3 percent pyrethrins. If the ground flowers of pyrethrum are used, the dust should contain at least 0.6 percent of pyrethrins.

Tompkins and Thomas (15) have recently reported a mosaic disease affecting Chinese cabbage in California. The disease is characterized in the greenhouse by pronounced clearing of the veins, which commences near the base of the leaf and then gradually spreads over the entire leaf. After 3 to 4 weeks, the younger inner leaves begin to show a coarse mottling. The older leaves continue to show clearing of the veins without any other change and persist in this condition until they die. There is slight stunting of the entire plant if it is infected early in the season, but if the infection is late the stunting may not become apparent.

Only a slight amount of soft rot has been observed in plantings made at Cheyenne. However, Shropshire and Kadow (11) report that in Illinois this is a serious disease in some years, and losses of 50 to 75 percent have been observed in plantings of Chinese cabbage. It usually appears late in the season in the field or after the plants have been harvested and placed in storage. Control measures consist of preventing mechanical injury to the plants during growth or harvesting, allowing the surface to dry before storage, and storing at temperatures of 35° to 37° F. with medium humidity and good ventilation.

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